REPORT ON

USE OF WATER GAS TAR AS A WOOD PRESERVATIVE

By

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April 17, 1999

QUALIFICATIONS

I have extensive experience working with Government regulatory agencies, State agencies that specify and use treated wood, standard writing organizations such as American Wood-Preservers' Association and American Society for Testing and Materials. I also have nearly 38 years experience providing information on wood deterioration/wood protection, wood treatment/wood preservation, wood preservation standards and specifications, and Government regulations concerning the use of wood preservatives. Twenty-nine of those years were spent doing research at the U.S Forest Products Laboratory. I have conducted research on basic problems associated with wood protection involving the use of creosote to treat and preserve wood products. My *Curriculum Vitae* has more detail and is attached as appendix A. A list of my publications is attached as appendix B.

SCOPE OF WORK

On behalf of your client, Northern States Power Company (NSP), you have asked my opinion with respect to the following: could tar resulting from the production of manufactured gas, at a plant which utilized a carbureted water gas process, be used as a wood preservative?

RESEARCH

Contacts:

1) In October, 1998 I contacted Mr. Howard Simon, Allied Signal Inc. about the specifications for water gas tar (WGT) vs. coke oven tar (COT). Howard provided me with the following information:

	Water Gas Tar	C.O.Tar
Specific Gravity @ 60°F	1.023	1.20
Water, %	20	5
Ash, %	4	0.2
Xylene Insolubles, %	21	15
Oil Content, %	42	35

The WGT was used as produced to treat wood, however the COT was distilled to produce coal tar creosote (CTC). In some cases some COT was added back to creosote to increase the viscosity of the CTC. In this case the best comparison can be made between the tars of the two systems. The specification that is probably most important here is the difference in the specific gravities. These differences (1.023 and 1.20) are considered significant in the wood preserving industry because the higher specific gravity systems tend to perform better in service. Howard Simon is Technical Director for Allied Signal Inc., Carbon Materials & Technologies, 3330 South Third Street, Ironton, OH 45638, Phone 740/533-6502. I've known Howard for many years and he has an excellent background in organic tar preservative products.

2) On October 7, 1998 I spoke with Mr. Dan Davies, retired from Koppers Co., Pittsburgh, PA. It was Dan's understanding that WGT was low enough in viscosity that it could be used to treat wood just as it came from the gas plant. Dan Davies was Manager of Research & Development, Forest Products Group, Koppers Co. until he retired 16 years ago. As manager, Dan had the responsibility of wood preservatives including creosote and all treating processes. His address now is Dan Davies, 1020 West Olympia St., Hernando, FL . Phone 352/746-1302.

References

Tar produced from the production of manufactured gas, at a gas plant which utilized a carbureted

water gas process, would be characterized as water gas tar (WGT). To determine whether WGT was used as a preservative, I reviewed the proceedings from the American Wood-Preservers' Association (AWPA), beginning in 1908 through 1937 to look for references relating to the use of WGT as a preservative for wood. According to the AWPA statistical data the first reported use of WGT for wood preservation was in 1915.

The following table shows the comparative use of WGT to domestic CTC for the years 1915 to 1936 for the treatment of wood:

Year	Refined WGT + WGT Solution[1] (gallons)	Total Domestic Creosote (gallons)	WGT as a Percent of The Total Domestic Creosote (percent)
1915	2,024,545	43,358,435	4.7
1916	1,436,083	46,754,818	3.1
1917	2,977,392	57,282,596	5.2
1918	2,822,652	50,610,650	5.6
1919	3,482,761	61,474,865	5.7
1920	5,776,984	61,030,739	9.5
1921	5,527,426	49,331,725	11.2
1922	3,656,549	52,273,833	7.0
1923	4,329,667	66,620,940	6.5
1924	6,493,587	80,918,277	8.0
1925	4,397,020	80,333,092	5.5
1926	3,041,790	92,831,629	3.3
1927	3.607,794	130,106,386	2.8
1928	2,305,773	149,671,196	1.6
1929	1,321,161	134,063,664	1.0
1930	1,622,678	145,595,733	1.1
1931	846,118	113,510,630	0.8
1932	50,000	85,100,966	0.1
1933	633,923	66,246,682	1.0
1934	9,715	95,504,382	0.0
1935	284,724	106,736,966	0.3
1936	No values	124,456,892	0.0

[1] I was unable to learn the difference between "refined water gas tar" and "water gas tar solution" and so have combined them for these purposes. In the case of coal tar creosote the use of the term "solution" means that a certain amount of coal tar has been added back in to the creosote

From the data on this table it is almost certain that WGT was being used as a wood preservative prior to 1915 but just was not reported in the AWPA statistical data. For example other reports show that WGT was used to treat wood paving block as early as 1889 for use in New Orleans. As you can see, the level of use was rather constant up to 1919, then peaked in the early 1920's and begin to decline thereafter.

From the above table it appears the highest consumption of WGT was during the years from 1917 to 1925. This nine year period accounts for about 39.5 million gallons, or 70 % of the total WGT consumed from 1915 to 1936. For the same nine year period, from 1917 to 1925, the

consumption of WGT made up an average of 7 % of the domestic creosote.

The following table gives the range of prices paid for these wood preservatives during the years 1917 to 1929, the only years for which I've been able to find price information for WGT.

Year	Refined WGT (cents per gallon)	WGT Solution (cents per gallon)	CTC (cents per gallon)	CTC Solution (cents per gallon)
1917	4.25 to 6.50	— —	8.00 to 17.00	— —
1918	5.36 to 7.50	— —	7.71 to 25.00	— —
1919	6.31 to 10.00	8.00	13.00 to 21.30	12.00 to 13.50
1920	6.31 to 10.00	8.00 to 15.00	9.80 to 45.00	9.30 to 26.00
1921	8.37 to 9.25	— —	14.00 to 32.50	9.00 to 18.00
1922	8.00 to 14.00	— —	13.20 to 18.50	12.00 to 25.00
1923	8.00	8.56	14.50 to 23.00	9.31 to 20.00
1924	8.00 to 9.98	11.00 to 12.00	14.20 to 20.00	13.23 to 22.40
1925	10.00	10.00 to 12.00	12.50 to 23.50	12.00 to 19.30
1926	7.50	11.00 to 12.00	14.0 0 to 27.00	10.00 to 20.00
1927	9.00	10.00 to 12.00	14.50 to 35.00	12.00 to 16.50
1928	7.20	11.00	14.25 to 28.00	12.00 to 17.00
1929	12.00	— —	13.00 to 29.00	9.80 to 16.00

A comparison of cost on an annual bases shows that WGT was lower in cost than CTC in each year listed in the table. The average price for refined WGT for the years 1917 to 1929 was 8.48 cents per gallon while the average price for CTC over the same period was 19.51 cents per gallon.

DISCUSSION

It is important to realize that the wood preserving industry was still in its infancy during the time periods pertinent to this research (early 1900's through the mid 1930's). In tests comparing the performance of water gas tar to coal tar creosote as a preservative, coal tar creosote performed somewhat better. However, water gas tar was less expensive, thus increasing its attractiveness from the perspective of cost-effectiveness. In addition, water gas tar was easier to transport via tank cars because it was more liquid than coal tar creosote which many times had to be heated before it could be transferred.

If a treatment facility were located close to a manufactured gas plant, one would expect the wood treatment facility to use the readily available and considerably less expensive water gas tar.

CONCLUSION

On the basis of the foregoing facts and opinions, my professional opinion is as follows:

1. A manufactured gas plant, which used a carbureted water gas process, would produce a tar characterized as "water gas tar".

2. Water gas tar could be and was used as a wood preservative during the later part of the last century, starting in 1889 and continuing through 1935.

3. It would be possible to use water gas tar as a wood preservative in the same form the water gas tar would come from the manufactured gas plant. In other words, the water gas tar would not require processing before being used in the treatment of wood.

4. The price of water gas tar was less than the price of coal tar creosote. A wood treatment facility located near a source of water gas tar would be expected to use the water gas tar, rather than incurring the additional expense of purchasing the more expensive coal tar creosote.

Sincerely,

Lee R. Gjovik

Lee R. Gjovik

Appendix A

Curriculum Vitae

Lee R. Gjovik
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CONSULTANT

Experienced consultant providing problem solving analyses to manufacturers, builders, architects, contractors and the consuming public on wood related problems. Extensive experience working with Government regulatory agencies, State agencies that specify and use treated wood, standard writing organizations such as American Wood-Preservers' Association and American Society for Testing and Materials.

Professional Highlights

Thirty-six years experience providing information on wood deterioration/wood protection, wood treatment/wood preservation, wood preservation standards and specifications, and Government regulations concerning the use of wood preservatives. I was assigned the leadership responsibility by USDA to develop the biological and economic assessment of the three major types of wood preservatives for regulatory purposes. I have had sole responsibility for preparing and revising the Federal Specification for wood preserving practices and have published over 80 research papers on the general subject of wood preservation.

Research

Conducted research on basic problems associated with wood protection such as treating different species of wood and treating different forms of wood. I have presented my research results at National and International meetings, workshops and seminars. In addition I have organized a number of national workshops on wood preservation.

EDUCATION AND PROFESSION

Education

B.S. Wood Science and Technology University of Minnesota, 1959
M.S. Wood Science and Technology University of Minnesota, 1961

Professional Employment

1989-present	Consultant
1976-1989	Research Specialist/Wood Preservation, Forest Products Laboratory, Madison, WI.
1969-1976	Supervisory Research Forest Products Technologist, Forest Products Laboratory, Madison, WI
1961-1969	Research Forest Products Technologist, Forest Products Laboratory, Madison, WI

Professional Activities

1972-1974	Chairman of Ad Hoc Committee, American Wood-Preservers' Association

1975-1982	Chairman of Committee on Piling, American Wood-Preservers' Association
1982-1985	Executive Committee, American Wood-Preservers' Association
1985-1986	Chairman of the Technical Program Committee, American Wood-Preservers' Association
1986-1987	Chairman of the Committee on Committees, American Wood-Preservers' Association
1987-1990	President and past president, American Wood-Preservers' Association
1975-1982	Standards Review Committee, American Wood Preservers Bureau
1974-1982	Chairman of Technical Committee on Treated Wood Products, Forest Products Research Society
1969-1981	Chairman of Subcommittee on Durability and Exposure, American Society for Testing and Materials
1986-present	Chairman of Preservative Subcommittee, American Society for Testing and Materials
1966-1980	Treatment and Coatings Standard Committee National Wood Window and Door Association
1968-present	International Research Group on Wood Preservation
1974-present	International Union of Forestry Research Organization, Division 5
1977-present	Railway Tie Association
1975-1985	Wood Preservative Advisory Task Force of FAO
1977-1984	Team Leader of the USDA Assessment Team for RPAR Review of Pentachlorophenol, Creosote, and Arsenical Preservatives

Honors and Distinctions

1972	Cash award from the U.S Government for research contributions on the modified double-diffusion system of treating wood in Alaska
1980	Cash award from the U.S. Government for leadership in preparing the USDA/States/EPA Assessment Team Report
1972-present	Guest lecturer at the University of Wisconsin.
1975-present	Guest lecturer at the University of Minnesota.

References

Will be provided upon request.

Appendix B

Gjovik's Publications

1. Baechler, Roy H. and Lee R. Gjovik.
   1965. *Relation between distillation pattern of creosote and its effectiveness as determined by soil-block method.* AWPA Proc. 61:130-139.

2. Gjovik, Lee R.
   1968 Fundamentals of Wood Preservation. Internal FPL Report.

3. Gjovik, Lee R. and Roy H. Baechler.
   1968. Field tests on wood dethiaminized for protection against decay. Forest Prod. J. 18(1):25-27.

4. Baechler, Roy H., Lee R. Gjovik, and Henry G. Roth.
   1969. Assay zones for specifying preservative-treated Douglas-fir and southern pine timbers. AWPA Proc. 65:114-121.

5. Baechler, Roy H., Lee R. Gjovik, and Henry G. Roth.
   1969. Studies of several methods for determining suitability of creosote for marine use. AWPA Proc. 65:16-27.

6. Baechler, Roy H., Lee R. Gjovik, and Henry G. Roth.
   1970. Marine tests on combination-treated round and sawed specimens. AWPA Proc. 66:249-256.

7. Gjovik, Lee R., and Roy H. Baechler.
   1970. Treated wood foundations for buildings. Forest Prod. J. 20(5):45-48.

8. Gjovik, Lee R., Henry G. Roth, and Linda F. Lorenz.
   1970. Quantitative differences in preservative penetration and retention in summerwood and springwood of longleaf pine. AWPA Proc. 66:260-62

9. Johnson, Bruce R., and Lee R. Gjovik.
   1970. Effect of Trichoderma viride and a contaminating bacterium of microstructure and permeability of loblolly pine and Douglas-fir. AWPA Proc. 66:234-240.

10. Mueller, Linc A., Don C. Markstrom, and Lee R. Gjovik.
    1970. Treating resistant Rocky Mountain species by regular and modified double-diffusion methods. Forest Prod. J. 20(1):17-20.

11. Gjovik, Lee R.
    1971. Protection of wood in use—Wood preservation research. Proc. of the decade of opportunity-FPU in the 1970's. p. 161-164.

12. Gjovik, Lee R., and Harley L. Davidson.
    1971. Comparison of wood preservatives in Mississippi post study. U.S. Forest Serv. Res. Note FPL-01.

13. Gjovik, Lee R.
    1971. Groundline preservative applications as supplemental treatment for standing poles. Proc. of the 5th Wood Pole Institute, Colorado State Univ., p. 20-34.

14. Davidson, Harley L., and Lee R. Gjovik.
    1972. Dual treatment of marine piles: Predrying and treatment. AWPA Proc. 68:162-167.

15. Gjovik, Lee R., B. Alan Bendtsen, and Henry G. Roth.
    1972. Condition of preservative-treated cooling tower slats after 10 years service. Forest Prod. J. 22(4):35-40.

16. Gjovik, Lee R., Henry G. Roth, and Harley L. Davidson.
1972. Treatment of Alaskan species by double-diffusion and modified double-diffusion methods. US. Forest Serv. Res. Pap. FPL 182.

17. Lorenz, Linda F., and Lee R. Gjovik.
1972. Analyzing creosote by gas chromatography: Relationship to creosote specifications. AWPA Proc. 68:3-39.

18. Smith, Roger S., and Lee R. Gjovik.
1972 Inter-laboratory testing of wood preservatives using ASTM D 1413-61. Wood and Fiber 4(3):170-178.

19. Chudnoff, Martin, R. Wawriw, and Lee R. Gjovik.
1973. Effectiveness of groundline treatments of creosoted pine poles under tropical exposure. For. Prod. J. 23(9):80-84.

20. Gjovik, Lee R., and Harley L. Davidson.
1973. Comparison of wood preservatives in Mississippi post study. U.S. Forest Serv. Res. Note FPL-01.

21. Gjovik, Lee R., and Harley L. Davidson.
1973. Comparison of wood preservatives in stake tests. U.S. Forest Serv. Res. Note FPL-02.

22. Johnson, Bruce R., Lee R. Gjovik, and Henry G. Roth.
1973. Single- and dual-treated panels in a semi-tropical harbor: Preservative and retention variables and performance. Progress report No. 1. AWPA Proc. 69:207-214.

23. Gjovik, Lee R.
1974. Wood preservatives and the environment: Treated wood. AWPA Proc. 70:114-115.

24.Gjovik, Lee R. and Roy H. Baechler
1974 Federal specification, wood preservation: Treating practices. TT-W-571j (AGR-AFS)

25. Gjovik, Lee R. and Harley L. Davidson.
1975. Comparison of wood preservatives in Mississippi post study. U.S. Forest Serv. Res. Note FPL-01.

26. Gjovik, Lee R., and Harley L. Davidson.
1975. Comparison of wood preservatives in stake tests. U.S. Forest Serv. Res. Note FPL-02.

27. Gjovik, Lee R., and Harley L. Davidson.
1975. Service records on treated and untreated fence posts. U.S. Forest Serv. Res. Note FPL-068.

28. Johnson, Bruce R., Lee R. Gjovik, and Roy H. Baechler.
1975. Preservative treatment by double-diffusion and its application to tropical woods. Proceedings of the IUFRO Division 5 Subgroup 55.03 Wood Protection, p. 163-171.

29. Johnson, Bruce R., Lee R. Gjovik, and Dan F. Caulfield.
1975. Leachability of pentachlorophenol from red oak. U.S. Forest Serv. Res. Pap. FPL 226.

30. Boone, Sidney R., Lee R. Gjovik, and Harley L. Davidson.
1976. Treatment of sawn hardwood stock with double-diffusion and modified double-diffusion methods. U.S. Forest Serv. Res. Pap. FPL 265.

31. Gjovik, Lee R.
1976. Evaluation of groundline preservative application for poles. Proc. of the 6th Wood Pole Institute, Colorado State Univ., p. 149-167.

32. Gjovik, Lee R. and Roy H. Baechler.
1977. Selection, production, procurement and use of preservative treated wood, supplementing Federal Specification TT-W-571. U.S. Forest Serv. Gen. Tech. Rep. FPL-15.
33. Rowell, Roger M., John M.Black, Lee R. Gjovik, and William C. Feist.
1977. Protecting log cabins from decay, U.S. Forest Serv. Gen. Tech. Rep. FPL-11.

34. Gjøvik, Lee R.
1977. Pretreatment molding of southern pine: Its effect on the permanence and performance of preservatives exposed in seawater. AWPA Proc. 73:142-153.

35. Baechler, R. H., Lee R. Gjovik, and H.L. Davidson.
1978. 1948 Cooperative Creosote Project: Review of results of field tests on posts and 2 x 4 stakes. AWPA Proc. 74:173-180.

36. DeGroot, Rodney C., T.W. Popham, Lee R. Gjovik, and T. Forehand.
1979. Distribution Gradients of arsenic, copper, and chromium around preservative-treated wooden stakes. J. Environ. Qual. 8(1):39-41.

37. DeGroot, Rodney C., William C. Feist, Wallace E. Eslyn, and Lee R. Gjovik.
1979. Protecting wood fences for yard and Garden, A3052, University of Wisconsin Extension, 6 p.

38. Gjovik, Lee R., and Harley L. Davidson.
1979. Comparison of wood preservatives in stake tests. U.S. Forest Serv. Res. Note FPL-02.

39. Laundrie, James F., Gary C. Meyers, Lee R. Gjovik, Henry J. Hall, and Roland 0. Gertjejansen.
1979. Evaluation of particleboards and hardwoods from mixed Ghanaian hardwoods after one year exposure in the Caribbean National Forest of Puerto Rico. ASDA Forest serv., Forest Prod. Lab., Madison, WI, Rept to: Office of Sci. and Technol., Development Support Bur., Agency for Inter. Development, U. 5. Dept. of State.

40. Gjovik, Lee R., Warren S. Thompson, Van Kozak, Ed A. Woolson, David Johnson, Darrel D. Nicholas, William Dost, and James T. Micklewright.
1980. Biological and economic assessment of pentachlorophenol, inorganic arsenicals, and creosote. USDA Tech. Bull. No. 1658, Vol. I, Wood preservatives uses.

41 Gjovik, Lee R., Warren S. Thompson, Van Kozak, Ed A. Woolson, David Johnson, Darrel D. Nicholas, William Dost, and James T. Micklewright.
1980. Biological and economic assessment of pentachlorophenol, inorganic arsenicals, and creosote. USDA Tech. Bull. No. 1658, Vol. II, Non-wood preservatives uses.

42. McGinnis, Gary, L. Ingram, and Lee R. Gjovik.
1981. The relative amount of pentachlorophenol volatilization from treated wood. AWPA Proc. 77:102-108.

43. McGinnis, Gary., Leonard Ingram, G. Jasperse, and Lee R. Gjovik.
1981. The effect of solvent systems on the volatilization of pentachlorophenol from treated wood. AWPA Proc. 77:109-117.

44. Gjovik, Lee R., and David I. Gutzmer.
1981. Comparison of wood preservatives in stake tests. U.S. Forest Serv. Res. Note FPL-02.

45. Woolson, Ed A., and Lee R. Gjovik.
1981. The valence state of arsenic on treated wood. AWPA Proc. 77:15-22

46. DeGroot, Rodney C., Lee R. Gjovik, and Andrew J. Baker.
1981. Preservative-treated wood for foundations. U.S. Forest Serv. Res. Note FPL-0245.

47. Micklewright, James T., and Lee R. Gjovik.
1981. Wood preservation statistics update. AWPA Proc. 77:143-147

48. Gjovik, Lee R.
1981. The biologic and economic assessment of pentachlorophenol, inorganic arsenicals and creosote. Vol. I. Proc. of the 7th Wood Pole Institute, Colorado State Univ., p. 151-168.

49. Saur, James, P. Walcheski, Darrel D. Nicholas, and Lee R. Gjovik.
1982. Concentration of airborne pentachlorophenol within treated wood structures. AWPA Proc. 78:169-173.

50. Ingram, Leonard Jr., Gary D. McGinnis, Lee R. Gjovik, and G. Roberson.
1982. Migration of creosote and its components from treated piling sections in a marine environment. AWPA Proc. 78:120-128.

51. Gjovik, Lee R. and James T. Micklewright.
1982. Wood preservation: How important is the wood treating industry. Southern Lumberman December Issue.

52. Bendtsen, B.Alan, Lee R. Gjovik, and S.P. Verrill.
983. Mechanical properties of longleaf pine treated with waterborne-salt preservatives. U.S. Forest Serv. Res. Pa. FPL 434.

53. Gjovik, Lee R.
1983. Treatability of southern pine, Douglas-fir, and Engelmann spruce heartwood with ammoniacal copper arsenate and chromated copper arsenate. AWPA Proc. 79:18-30.

54. Saur, James M., Paul J. Walcheski, and Lee R. Gjovik.
1983. The level of respirable arsenic on the surface of treated wood in service. AWPA Proc. 79:66-70.

55. Gjovik, Lee R., and David I. Gutzmer.
1983. Comparison of wood preservatives in stake tests. U.S. Forest Serv. Res. Note FPL-02, 89 p.

56 Hartford, Winslow H. and Lee R. Gjovik
1983. Examination of various penta stake test results by log-probability and performance index models. AWPA Proc. 79:96-121

57. Gaby, Louis T., and Lee R. Gjovik.
1984. Treating and drying composite lumber with waterborne preservatives: Part I. Short specimen testing. Forest Prod. J. 34(2):23-26.

58. Spelter, H.N., and Lee R. Gjovik.
1984. The cost of wood versus masonry. New England Builder 2(9).

59. Ingram, Leonard L., Gary D. McGinnis, Lee R. Gjovik, and David A. Webb.
1984. The effects of temperature, air flow rates, and coating systems on the vaporization of creosote compounds from treated wood. AWPA Proc. 80:97-104

60. Gjovik, Lee R. and David I. Gutzmer.
1985. Comparison of wood preservatives in stake tests. U.S. Forest Serv. Res. Note FPL-02, 100 p.

61. Sell, Jorgen and Lee R. Gjovik.
1985. Preservative treatment of micro incised spruce with ACA and CCA. Holz als Roh- und Werkstoffe. Vol 43:482.

62. Baechler, Roy H. and Lee R. Gjovik.
1986. Looking back at 75 years of research in wood preservation at the US. Forest Products Laboratory. AWPA Proc. 82:133-148.

63. Hall, Henry J., Lee R. Gjovik, Elmer L. Schmidt, Roland F. Gertjejansen and James F. Laundrie.
1987. Subtropical testing of ACA-treated hardwood particleboard. Forest Prod. J. 34(4):49-53.

64. Gjovik, Lee R.
1987. Double diffusion preservative treatment. FPL Techline

65. Gjovik, Lee R.
1987. A method of preserving Alaska woods. A University of Alaska Publication.

66. Gjovik, Lee R.
1987. Modified double diffusion treatment of White Spruce, Sitka Spruce and Western Hemlock from Alaska. Progress Report

67. Gjovik, Lee R. and David I. Gutzmer.
1987. Comparison of wood preservatives in stake tests. U.S. Forest Serv. Res. Note FPL-02, 98 p.

68. Gjovik, Lee R.
1987. Wood Preservation Chapter 18 in the Wood Handbook. USDA—FS. Agriculture Handbook 72.

69. Webb, David A., and Lee R. Gjovik.
1988. Treated wood products, their effect on the environment. AWPA Proc. 84:254-265.

70. Winandy, Jerrold E., R. Sidney Boone, Lee R. Gjovik, and Pamela L. Plantinga.
1989. ACA and CCA preservative treatment and redrying effects on bending properties of Douglas-fir. AWPA Proc. 85:106-118.

71. Gjovik, Lee R. and David I. Gutzmer.
1989. Comparison of wood preservatives in stake tests. U.S. Forest Serv. Res. Note FPL-02, 105 p.

72. Gjovik, Lee R.
1990 Preservative saturated pads for protection of exposed wood joints. AWPA Proc. 86:106.

73. Gjovik, Lee R.
1991. Wood preservation research committee report. AWPA Proc. 87:119-143.

74. Gjovik, Lee R. and David R. Schumann.
1992. Treatability of native softwood species of the Northeastern United States. U.S. Forest Serv. Res. Paper FPL-RP-508.

75. Gjovik, Lee R.
1992. Wood preservation research committee report. AWPA Proc. 88:76-99.

76. Markstrom, Donald C. and Lee R. Gjovik
1992. Service life of treated and untreated Black Hills ponderosa pine fence posts. Rocky Mountain Forest and Range Exp. Sta. U.S. Forest Serv. Res. Paper RM-300

77. Gjovik, Lee R.
1993. Wood preservation research committee report. AWPA Proc. 89:105-128.

78. Gjovik, Lee R.
1994. Wood preservation research committee report. AWPA Proc. 90:88-95.

79 Kressbach, John N., Lee R. Gjovik and Ronald W. Wolfe
1996. Metrication of Pole Standard. To be published in the Proceedings of the Southeastern Pole Conference.

80 Gjovik, Lee R. and John N. Kressbach
1996 Revision of American National Standards Institute O5.1M for Poles. Hopefully To be Published by the Alliance for Telecommications Industry Solutions.

81. Kressbach, John N., Lee R. Gjovik and Ronald W. Wolfe
1996. ANSI Plans for Metrication., Western Red Cedar Association., Seattle WA

82 Degroot, Rodney C., Lee R. Gjovik and Douglas Crawford
1997 Field Durability of CCA- and ACA-Treated Plywood Composed of Hardwood and Softwood Veneers. To be published in the Forest Products Journal.

83 Markstrom, Donald C. and Lee R. Gjovik
1998 Service Life of Rocky Mountain Area Fenceposts Treated by Double-Diffusion Methods. To be published in the Rocky Mountain Research Station Paper.

84 Kressbach, John N. and Lee R. Gjovik
1999 Utility zzpole Quality Concepts—Back to Basics. To be published in the 1999 AWPA Proceedings.

Appendix C

1912 Proceedings, American Wood-Preservers' Association

1913 Proceedings, American Wood-Preservers' Association

1916 Proceedings, American Wood-Preservers' Association

1917 Proceedings, American Wood-Preservers' Association

1918 Proceedings, American Wood-Preservers' Association

1919 Proceedings, American Wood-Preservers' Association

1920 Proceedings, American Wood-Preservers' Association

1921 Proceedings, American Wood-Preservers' Association

1923 Proceedings, American Wood-Preservers' Association

1925 Proceedings, American Wood-Preservers' Association

1928 Proceedings, American Wood-Preservers' Association

1930 Proceedings, American Wood-Preservers' Association

1931 Proceedings, American Wood-Preservers' Association

1932 Proceedings, American Wood-Preservers' Association

1935 Proceedings, American Wood-Preservers' Association